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SWIMBLADDER STUDIES.(U)
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NEW LONDON LABORATORY
NAVAL UNDERWATER SYSTEMS CENTER
NEW LONDON, CONNECTICUT

SWIMBLADDER STUDIES

by

LCDR E. H. Wheeler, USNR

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INTRODUCTION

Isaacs-Kidd midwater trawl collections taken during JOAST on Station 10 were used in a study of swimbladder condition in fishes from the deep-scattering layer (DSL). Trawl #2 (4 Nov 70, 1005-1325 hrs) sampled at a depth of 825 m; the DSL was located at a median depth of 840 m, ranging from 780-910 m. This trawl most closely approximated the DSL depth and examination of swimbladders was restricted to fishes from trawl #2.

ADMINISTRATIVE INFORMATION

This report is the result of a two-week active duty training assignment given to the author by Code 2213. LCDR Wheeler, a U. S. Navy Reservist, holds a Ph.D. degree in Biological Oceanography. He is currently an assistant professor at the University of New Hampshire. The project described herein directly supports his interests in midwater organisms and also directly supports the work being conducted by the Ocean Science Department. This report was prepared under NUSC/NL Project Title Biological Reverberation as it Affects ASW Operations, C. L. Brown, NUSC/NL Principal Investigator. The sponsoring activity was NAVSHIPS, Code OOV1K, B. K. Couper Program Manager.

The objectives of this study were as follows:

1. To describe the condition of the swimbladder in the abundant species of the collection, including measurements where feasible.

AND

2. To determine the effect of formaldehyde preservation on the swimbladder.

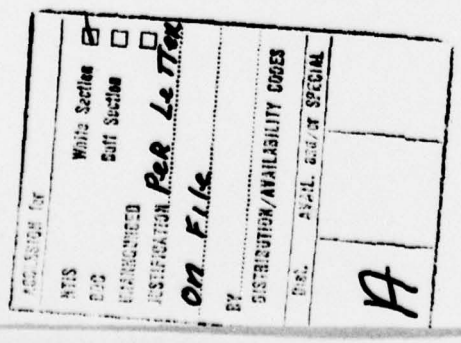
Methods

Individual fish from trawl #2 were dissected and examined under a dissecting microscope. Swimbladder measurements (major axis) were made with an ocular micrometer. Swimbladder volume estimates were attempted in selected, larger fish by filling the bladder with water from a calibrated syringe. A small-bore, gas-chromatograph delivery needle was used to successfully penetrate the swimbladder wall; however, the syringe was of too great a capacity for the needle and excessive pressure was required to drain and refill the swimbladder. This approach has the potential for being a quick method of obtaining an accurate estimate of swimbladder volume.

Results

The most abundant species in the samples from trawl #2 were Cyclothone braueri Jespersen and Taning, and C. acclinidens Garman (tentative identification). Juvenile myctophids and adult myctophids were next in abundance but were far outnumbered by Cyclothone. Occasional individuals of the genera Chauliodus and Stomias were seen. No attempt was made to enumerate and identify the entire collection of samples from trawl #2.

Cyclothone braueri. Eight individuals of this species were dissected; standard lengths and swimbladder measurements appear below. No gas-filled swimbladders were seen in fishes ranging from 17.5 to 24 mm in standard length. Morphology of the bladder conformed closely to the description for this species in Marshall (1960). Repressed bladders were without an obvious lumen or cavity and were often distorted or flattened.



Specimen No.	Standard Length (mm)	Swimbladder(major axis; mm)
13	24	--
14	23.5	2.33
15	22	2.33
16	23	--
17	20	1.66
18	22.5	1.80
21	17.5	--
22	19	1.96

Cyclothone acclinidens. This species of Cyclothone was less numerous by at least an order of magnitude compared to C. braueri. The identification here is tentative since there are two other species (C. livida and C. microdon) with similar dark pigmentation over the body. Differences in premaxillary dentition in combination with more subtle characters separate these forms.

Fourteen individuals were dissected. No gas-filled swimbladders were seen in specimens ranging from 16 to 23 mm standard length. Swimbladders were generally atrophied and often situated between two discrete pads of fatty tissue lying fore and aft of the reduced bladder. Fat accumulation was variable in extent and did not appear to be correlated with standard length (See data sheets).

Specimen No.	Standard Length (mm)	Swimbladder (major axis; mm)
1	22.5	1.33
2	23	--
3	22	0.83
4	21	--
5	21	--
6	20	--
7	19	--
8	21	--
9	21	1.76
10	20.5	--
11	22.5	0.67
12	20	--
19	16	1.40
20	16	--

Juvenile Myctophidae. Next in abundance were small, immature individuals of the family Myctophidae. Identification was not possible although the eight specimens dissected appeared to be of the same species in general body form, photophore configuration and internal anatomy. The swimbladder was not fat-invested but was thin-walled and easily ruptured when attempts were made to excise it from the body cavity. No gas-filled bladders were noted; however, several had the appearance of being fully extended but were filled with clear fluid.

Specimen No.	Standard Length (mm)	Swimbladder(major axis; mm)
23	19	---
24	15.5	---
25	20	---
26	17	1.83
27	17	---
28	17	2.50
29	17	2.56
30	17	2.80

Myctophidae sp. Four larger myctophids ranging from 23 to 32.5 mm were dissected and the swimbladders in these fishes are characterized by the prominent development of gas-gland tissue along the ventral and lateral portions of the bladder. The bladders, though appearing normal (Marshall, 1960), were fluid-filled and when pressed with a forcep tip seemed to be whole.

Specimen No.	Standard Length (mm)	Swimbladder(major axis; mm)
31	31	3.00
32	32.5	3.66
33	29.5	3.50
34	23	2.90

Discussion

All species examined were physoclists, i.e., there was no pneumatic duct linking the swimbladder with the foregut. The condition of the swimbladder appears to be variable among fishes of the same taxon and among fishes of similar standard length. If reverberation of sound by Cyclothone species is suspected because of the abundance of this genera

in samples taken within the DSL, the characteristics of sound-scattering by fat-invested organs must be evaluated before firm conclusions can be reached as to the contribution of these numerous fishes to an observed DSL. Larval Cyclothone are known to have gas-filled swimbladders (Marshall, 1960, and others); however, none were found in the samples and their small size would appear to exclude them from midwater trawl collections unless a much finer net is used.

Juvenile Myctophidae and smaller adult myctophids seem to be more likely as the sound scattering component of these samples. That no gas-filled bladders were found may be an artifact of formaldehyde preservation. This preservative changes the structure of proteins by the addition of methyl groups and therefore would have a significant effect on the properties of thin membranes. Perhaps the bladder membrane loses its gas-retention capability and the bladder gradually fills with fluid after preservation. This hypothesis would explain the finding of intact, fully-formed bladders without gas. It is also possible that small ruptures of the bladder occur as the captured fish are brought to the surface and that these breaks in the membrane are too small to be detected upon dissection. Dissection of fresh specimens would resolve this question.

C L. Brown for
E. H. WHEELER, LCDR USNR

Reference cited:

Marshall, N. B. 1960. Swimbladder structure of deep-sea fishes in relation to their systematics and biology. Discovery Report No. 31, 122 pp.

F.H. Wheeler

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Note: C. = Cyclothone

C. livida, C. acclinidens, are dark (all dark sp. called C. acclinidens here) C. microdon
C. braueri are light, also the most abundant in samples.

JOAST Trawl # 2 Sta. 10 4 Nov 70 / 1005 - 1325 hrs / 825 m / DSL: 790 (780 - 910 m)

Specimen No.	Cod and Compartment	Remarks	Standard Length (mm)	Sw. Bl. (length) (dia)	
1. C. acc.	A	- Swbl lies forward of pelvic fin insertion. Covered with black peritoneum - bladder itself thick-walled, almost spherical - no gas apparent - fat droplets inside. Bl. plus gasgl elongate (40 dia @ 50x)	22.5	40	@ 30x
2. C. acc.	A	+ Same - no measurement of bladder	25	-	
3. C. acc.	A	+ Peritoneal cavity with many fat(?) bodies; ovaries well-developed. Swbl discrete, thin-walled, spheroidal, gasgland attached to posterior - entire organ elongate. Possibly gas filled. No bubble seen	22	~25	@ 30x
4. C. acc.	A	+ Swbl as in #3. - No gas in bladder. Fat accumulation apparently not developed in bladder itself but fore and aft of bladder + bladder then reduces inside. Swbl again nearly spherical.	21		
5. C. acc.	A	+ Swbl with atrophied bladder, flattened. Fat appearing as liquid drops.	21		
6. C. acc.	A	+ Swbl appears atrophied with liquid fat globules as in #5.	20		
7. C. acc.	A	+ Swbl flattened between two (thin and translucent) pads of fatty tissue. Thin-walled.	19		
8. C. acc.	B	+ Swbl atrophied - no evidence of fat deposition	21		
9. C. acc.	B	+ Whole Swbl excised, measured - appears completely invested with fat + faint suggestion of orig. bladder	21	53	@ 30x
10. C. acc.	B	+ atrophied swbl.	20.5		
11. C. acc	B	+ Swbl as in #4.	22.5	20	@ 50x
12. C. acc.	B	+ Swbl as in #10 (not excised)	20		
13. C. braueri	B	+ Swbl & associated fat lies above black peritoneum can be measured without dissection. Some remnants peritoneal tissue around base & retia mirabile. regressed Swbl at end of lobule. Completely surrounded by fat.	24		
14. C. braueri	B	+ Same as #13.	23.5	70	@ 30x
15. C. braueri	B	+ Same	22	~70	@ 30x
16. C. braueri	B	+ Swbl same but flattened and distorted.	25		
17. C. braueri	B	+ Swbl covered with pigmented peritoneum - Swbl same condition as #13: regressed	20		

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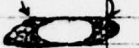
JOAST TRAWL # 2 (cont.) Sta. 10 (long axis)

Specimen No.		Coelom Compartment	Remarks	Standard Length (mm)	Sw. Bl. (div)	
18.	C. bowersi	B	+ Sw Bl same, slightly distorted.	22.5	54	@ 3x
19.	C. acc.	C	+ Sw Bl covered by peritoneum, fat (almost liquid) located fore and aft of regressed bladder.  fat-filled — no lumen observable.	16	42	@ 30.
20.	C. acc.	C	- Same as #19.	16		
21.	C. bowersi	C	+ Sw. bl. thin-walled without obvious fat deposits or globules. No gas either.	17.5		
22.	C. bowersi	C	+ fat invested as in #13	19	54	@ 30x
- Smaller Cyclothone sp. not available in this trawl. - no evidence for gas-filled bladder within these size ranges, for either						
23.	Juv. Myctoph.	B	+ swbl. appears ruptured.	19		
24.	Juv. Myctophid.	B	+ Same deposition. + Sw. bl wall thin, no fat	15.5		
25.	Juv. Myctophid.	B	+ Same	20		
26.	Juv. Myctophid.	B	+ Sw. Bl collapsed but + intact	17	55	@ 30x
27.	Juv. Myctophid.	B	+ Sw. Bl thin-walled + no gas.	17		
28.	Juv. Myctophid	B	+ Sw. Bl normally extended etc. but filled with fluid (effect of preservation in formaline)	17	75	@ 30x
29.	Juv. Myctophid.	B	+ Sw. Bl lies dorsal to stomach and attached along dorsal wall of gut cavity, tears if removed from attachment.	17	77	@ 30x
30	Juv. Myctophid	B	+ Sw Bl intact but fluid-filled and collapsed.	17	84	@ 30x
31.	Myctophid sp.	C	+ Sw Bl intact, fluid filled. Very thin-walled	31	90	@ 30x
32.	Myctophid sp.	C	+ Swbl as in #31. Thin-walled except for gas gland area.	32.5	110	@ 30x
33.	Myctophid sp.	C	+ Sw. bl. reduced in size (circum.), and surrounded by a gland. very little expansion would be possible.	28.5	105	@ 30x
34.	Myctophid sp.	C	+ Sw. bl. prominent - appeared inflated but was filled with clear liquid. Inflated appearance probably due to retention of shape by pre-served gas-gland tissue which surrounds most of sac, in fact, is an integral part of the organ wall. (+ See preserved dissection)	23	87	@ 30x